

U.S.S.N. 10,761,477

Remarks

Thorough examination by the Examiner is noted and appreciated.

The claims have been amended and new claims added to clarify Applicants disclosed and claimed invention.

Support for the amendments is found in the original claims and the Specification including the Figures. No new matter has been added.

For example, support for the amended claims is found in the original claims and in the Specification, for example at paragraph 0018:

"Preferably, a pulsing electrical current, having a pulse current density of typically about 10 mA/Cm<sup>2</sup>, is applied to the wafer by repeatedly reversing the polarity between the wafer and a metal electrode in the electrolyte solution. Accordingly, the wafer and the metal electrode alternate between being the cathode and the anode in the alternating pulsing phases. This causes repeated and alternating electroplating of metal from the electrolyte solution onto the seed layer and electrolytic etching of metal

U.S.S.N. 10,761,477

from the seed layer into the electrolyte solution. The net result is the removal of a thin layer of metal, as well as metal particles and defects, from the seed layer."

Support for new claims 21-23 is found in the Specification at paragraph 0019:

"In application of the pulsing electrical current to the wafer, during the cathode phase (in which the wafer has a negative charge), metal cations from the electrolyte solution are reduced and electroplated onto the seed layer. During the anode phase (in which the wafer has a positive charge), metal is etched from the seed layer by electrolysis. The net effect of the electroplating and electrolytic phases, combined with friction imparted to the seed layer by rotation of the wafer in the electrolyte solution, results in a net loss of metal from the seed layer, on the order of typically less than about 200 angstroms. Consequently, potential device-contaminating metal particles remaining in the via and/or trench openings after seed layer deposition are removed from the openings and typically dissolved in or removed from the electrolyte solution."

Support for new claims 24-25 is found in the Specification at paragraph 0030:

U.S.S.N. 10,761,477

"According to the invention, the wafer is immersed in an electropolishing electrolyte solution. Defects are removed from the seed layer and metal particles are removed from the via openings and/or trench openings on the wafer by rotation of the wafer in the solution during the simultaneous application of an electrical current to the wafer. The method is effective in removing particles from via and trench openings of all sizes, including openings having a width smaller than about 0.2  $\mu$ m for 0.13  $\mu$ m, 0.1  $\mu$ m and beyond advanced process technology."

**Claim Rejections under 35 USC 102**

1. Claims 1-6 and 13-14 stand rejected under 35 USC 102(b) as being anticipated by Uzoh et al. (US 5,807,165).

Uzoh et al. disclose a **planarization method** where a wafer having a planarization layer is mounted on a rotating carrier which is pressed against a rotating polishing pad with electrochemical slurry while applying a current to the carrier and the planarization layer (see Abstract; Figures 4-7). An initial portion of the excess metal on the planarization (surface) layer is removed electrochemically while chemical

U.S.S.N. 10,761,477

mechanical removal is dominant in removing remaining portions (col 4, lines 34-66).

Thus, Uzoh et al. fails to disclose several aspects of Applicants disclosed and claimed invention, operates by a different principle of operation, and is clearly insufficient to anticipate Applicants disclosed and claimed invention.

Applicants respectfully reject Examiners assertions of inherency that method of Uzoh et al. teaches:

"the mechanism of mechanically planarizing the wafer teaches that the metal would be coming off the surface as particles";

or that:

"applying waves of alternating polarity would inherently electroplate metal onto the metal layer as well as removing the metal layer"

Nevertheless, even if such assertions of inherency were supported by Examiner, such assertions do not help Examiner in making out a *prima facie* case of anticipation with respect to Applicants disclosed and claimed invention.

U.S.S.N. 10,761,477

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

2. Claims 1-2, 5, 13-14 and 16 stand rejected under 35 USC 102(e) as being anticipated by Guldi (US 6,689,686).

Guldi discloses an electroplating system including rotating of a wafer in an electrolyte solution where the current is controlled to prevent non-uniform growth of large grains (see Abstract). Guldi discloses that an important aspect of their invention is that the variable current electroplating process uses **smooth transitions to prevent sudden changes in the electric field**, which is taught to lead to the formation of larger grains (col 2, lines 3-14). Guldi teach both plating and deplating of a metal layer, but **teach away** from rapidly change of a current flow in the electrolyte solution (**i.e. a pulsed current**) (col 4, lines

U.S.S.N. 10,761,477

1-19).

Guldi et al. further teach a seed layer and teach a process of making the seed layer more uniform by a very slight deplating process at the beginning of the electroplating sequence (col 4, lines 28-34). Guldi et al. teach applying a continuous deplating current which is **gradually decreased (more negative) over time** (see col 4, lines 35-37). Guldi et al. **teach away** from a **pulsed current method** or an **alternating current method** (e.g., such as a square wave signal (col 4, lines 47-59).

Thus, Guldi fails to disclose several aspects of Applicants disclosed and claimed invention or recognize the problem or present a solution to the problem that Applicants have recognized and solved by their claimed invention.

Guldi does not disclose:

"A method for removing particles from a wafer surface comprising damascene openings lined with a metal seed layer comprising the steps of:

U.S.S.N. 10,761,477

providing an electrolyte solution comprising said metal;

immersing said wafer surface in said solution in spaced apart relation to an electrode and rotating the wafer in said solution; and

supplying a pulsed electrical current to said wafer and said electrode to result in a net removal of a portion of said metal seed layer prior to electroplating said metal to fill said damascene.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

With respect to claims 2 and 14, nowhere does Guldi disclose a **pulsed electrical current** or alternating pulses of positive and negative current.

Applicants respectfully reject Examiners assertion that the

method of Guldi would inherently remove particles from a wafer and Examiner has provided no support for this assertion. Rather, Guldi does not teach or suggest anywhere that particles may be removed, but rather teaches that the wafer **may or may not** be rotated at the initial stages of a plating operation, contrary to Applicants disclosed and claimed invention (see col 2, lines 60-65).

With respect to clam 16, Applicants respectfully reject Examiners assertion that the method of Guldi **inherently** teaches that the ratio of metal removed to the metal plated would be from about 2 to about 5 remove particles from a wafer and Examiner has erroneous support for this assertion. Rather, Figure 3 does not show a wave form, but shows a current trace over the various stages where portion 50 represents an initial removal of a portion of a seed layer by a gradual decrease (more negative) in the current level to continuously remove the seed layer (i.e., no electroplating taking place during this portion of the process) (see col 4, lines 24-26; lines 34-38).

"To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present



U.S.S.N. 10,761,477

in the thing described in the reference, and that it would be so recognized by persons of ordinary skill." *In re Oelrich*, 666 F.2d 578,, 581-582, 212 USPQ 323, 326 (CCPA 1981).

"In relying on the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." *Ex Parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990)

**Claim Rejections under 35 USC 103**

1. Claims 3, 7-12, 15 and 17-20 stand rejected under 35 USC 103(a) as being unpatentable over Guldi, above, and further in view of Taylor et al. (USPUB 2002/0056645).

Applicants reiterate the comments made above with respect to Guldi, above.

The fact that Taylor et al. teach the use of polyglycol

suppressors in a **pulsed current electroplating operation** to **achieve uniform filling** of recesses, does not further help Examiner in establishing a prima facie case of obviousness.

There is no apparent motivation to combine the teachings of Guldi, who teaches removing a portion of a seed layer by a **gradual change in current level** (continuous current), with the method of Taylor et al., who teach uniform filling of recesses with a **pulsed current**. The methods of Guldi and Taylor et al. operate by a different principle of operations (gradual change in continuous current versus a pulsed current). Even assuming arguendo, a proper motivation for combination, such combination does not produce Applicants disclosed and claimed invention.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"The prior art must provide a motivation or reason for the worker in the art, without the benefit of appellant's

U.S.S.N. 10,761,477

specification, to make the necessary changes in the reference device." *Ex parte Chicago Rawhide Mfg. Co.*, 223 USPQ 351, 353 (Bd. Pat. App. & Inter. 1984).

"A prior art reference must be considered in its entirety, i.e., as a whole including portions that would lead away from the claimed invention." *W.L. Gore & Associates, Inc., Garlock, Inc.*, 721 F.2d, 1540, 220 USPQ 303 (Fed Cir. 1983), cert denied, 469 U.S. 851 (1984).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." *In re Ratti*, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).

Thus, the cited references, singly or in combination fail to make out a *prima facie* case of anticipation or obviousness with respect to Applicants independent claims, and therefore Applicants dependent claims.

Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable

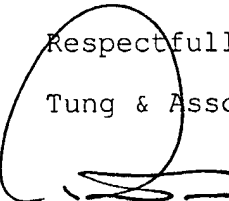
U.S.S.N. 10,761,477

action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

Tung & Associates



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